

**CLAIMS**

1. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form comprising:

5 a body having a chamber formed therein, the body having an open end and a power-source end, with the open end of the body forming a plasma source exit having an exit plane;

an array of confinement magnets encircling the body, whereby the body and the array of confinement magnets form a plasma generation reaction chamber;

10 an electron source filament connected to an AC power source located outside the body, said electron source filament being inserted into the plasma generation reaction chamber;

a gas port inserted through the power-source end of the body and into the plasma generation reaction chamber;

15 a DC power source located outside the body, and connected between the electron source filament and the body; and

an array of filtration magnets positioned near the plasma source exit, and parallel to the plasma source exit plane, said array of filtration magnets separating the reaction chamber into an upstream region containing the confinement magnets and a downstream region.

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2. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form as set forth in claim 1, wherein the electron source filament is formed of a material selected from the group consisting of tungsten, tantalum, and iridium.

3. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form as set forth in claim 1, wherein the body is formed of low carbon steel.

4. An apparatus for polishing diamond surfaces as set forth in claim 1, wherein the  
5 plasma is comprised of least 60% atomic oxygen ions.

5. An apparatus for polishing diamond surfaces as set forth in claim 1, wherein a discharge voltage applied between the DC power source and the electron source filament is between 50 and 150 volts.

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6. An apparatus for polishing diamond surfaces as set forth in claim 1, wherein a pressure of oxygen gas introduced into the plasma generation reaction chamber is between  $6.0 \times 10^{-5}$  and  $1.2 \times 10^{-4}$  Torr.

15 7. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form comprising

a magnetic cylinder having a cylindrical chamber formed therein and an open end and a power-source end, with the open end of the cylinder forming a plasma source exit having an exit plane;

20 a non-magnetic cooling jacket formed in a substantially annular and cylindrical shape positioned within the cylindrical chamber of the magnetic cylinder;

a substantially annular and cylindrical array of confinement magnets encased within said non-magnetic cooling jacket, whereby the magnetic cylinder and the array of confinement magnets form a plasma generation reaction chamber;

an electron source filament connected to an AC power source located outside the magnetic cylinder, said electron source filament being inserted through power-source end of the magnetic cylinder and into the plasma generation reaction chamber;

a gas port inserted through the power-source end of the magnetic cylinder and into the  
5 plasma generation reaction chamber;

a DC power source located outside the magnetic cylinder, and connected between the electron source filament and the magnetic cylinder; and

an array of filtration magnets positioned near the plasma source exit, and parallel to the plasma source exit plane, said array of filtration magnets separating the reaction  
10 chamber into an upstream region containing the confinement magnets and a downstream region.

8. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form as set forth in claim 7, wherein the electron source filament is formed of a  
15 material selected from the group consisting of tungsten, tantalum, and iridium.

9. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form as set forth in claim 7, wherein the magnetic cylinder is formed of low carbon steel.

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10. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form as set forth in claim 7, wherein the non-magnetic cooling jacket is formed of stainless steel.

11. An apparatus for polishing diamond surfaces by generating atomic oxygen ions in plasma form for polishing diamond surfaces as set forth in claim 7, further comprising a cylindrical molybdenum shield located between the non-magnetic cooling jacket and the plasma generation reaction chamber.
12. An apparatus for polishing diamond surfaces as set forth in claim 7, wherein the plasma is comprised of least 60% atomic oxygen ions.
13. An apparatus for polishing diamond surfaces as set forth in claim 7, wherein a discharge voltage applied between the DC power source and the electron source filament is between 50 and 150 volts.
14. An apparatus for polishing diamond surfaces as set forth in claim 7, wherein a pressure of oxygen gas introduced into the plasma generation reaction chamber is between  $6.0 \times 10^{-5}$  and  $1.2 \times 10^{-4}$  Torr.